central Rocky Mountain region on the succeeding day, it was forced southward by an area of high pressure from the north and disappeared by a gradual increase of pressure.

VII.—Number vii was central far to the north of Montana on the 29th. It was the most northerly depression traced during the month, and its course eastward is only approximately determined by stations which were in its southern quadrants. General rains occurred along the northern boundary and as far southward as the Lake region during its passage eastward on the 30th and 31st, and brisk to high winds occurred in the Lake region. It was central over the Gulf of Saint Lawrence at the close of the month.

VIII.—On the 30th the barometer was low over the plateau regions, and this disturbance was apparently moving slowly northward from Nevada towards Washington Territory, where it remained nearly stationary on the 31st, but as an extended barometric trough, covering the entire plateau region from Arizona to the northern boundary of the United States.

NORTH ATLANTIC STORMS FOR JULY, 1888.

[*Pressure in inches and millimetres; wind-force by Beaufort scale.*]

The paths of the depressions that appeared over the north Atlantic Ocean during July, 1888, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Eight depressions have been traced, of which five advanced eastward from the American coast north of the fortieth parallel; two first appeared over mid-ocean north of the fiftieth parallel, and one apparently developed off the eastern edge of the Banks of Newfoundland. The depressions generally pursued normal east to east-northeast tracks, except over and near Newfoundland, where they moved northeastward. Two storms are given probable paths from Newfoundland to the British Isles. From the 1st to the 5th a depression of moderate energy pursued an irregular path south of Nova Scotia and Newfoundland, and a depression of marked strength advanced from mid-ocean in about thirty-five degrees west longitude to the British Isles attended by fresh to whole gales. From the 6th to the 10th the barometer continued high over mid-ocean; to the westward of the forty-fifth meridian moderate gales were occasioned by the passage of a depression northeastward over Newfoundland; in the vicinity of the British Isles the weather was generally unsettled with moderate to fresh north to west gales and slowly rising barometer. From the 12th to the 16th, inclusive, a depression of considerable strength traversed the ocean from Nova Scotia to the British Isles. From the 17th to the 20th the pressure continued low with moderate to fresh gales over and west of the British Isles, while over the western portion of the ocean the barometer was high. Subsequent to the 20th the barometric fluctuations were frequent and marked over the entire ocean during the passage of three depressions of average summer strength, one of which is traced from the Gulf of Saint Lawrence to the northward of the fiftieth parallel and thence south of east to the British Isles from the 25th to the 29th, inclusive; a second advanced from east of Newfoundland to the British Isles from the 25th to the 28th, and a third developed southeast of Nova Scotia on the 29th and from thence passed northward over Newfoundland during the 30th.

In July, 1887, seven depressions were traced, of which two passed eastward over the northern extremity of Newfoundland and advanced to the northward of the British Isles; two moved eastward from the coast of the United States south of the forty-fifth parallel, and three first appeared over mid-ocean. The general course of direction of the depressions was east-northeast, and their rate of progression was, as a rule, slow. Barometric pressure falling below 29.00 (736.6) was reported on the 8th over mid-ocean, and on the 26th to the southward of Iceland. In July, 1888, the depressions that appeared over the north Atlantic, while being somewhat deficient in number when compared with those traced for corresponding months of previous years, were of average summer strength. A noteworthy feature of the month was the entire absence of important disturbances in the vicinity of the West Indies and over the Gulf of Mexico; it is also observable that the paths of the storms that passed eastward from the American continent were confined to unusually high latitudes.

In the following descriptions of the depressions traced, positions are given in degrees, latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This depression was central on the 1st south of the western extremity of Nova Scotia, where the barometric pressure fell below 29.70 (754.4). During the next four days the storm-centre pursued an irregular path west of the fiftieth meridian, after which it apparently moved northwestward under the influence of depression number 3, which was central on the 6th over the Gulf of Saint Lawrence.

2.—This depression was a continuation of depression number 9 traced for June, 1888, and was attended over mid-ocean by the severest disturbances of the month. On the 1st the storm was central in about N. 52°, W. 35°, with pressure falling below 29.20 (741.7) and fresh to strong gales from the forty-fifth meridian to the European coast. Moving slowly northeast to the fifty-fifth parallel by the 2d the depression is thence traced east and east-southeast over the British Isles by the 8th; subsequent to the 1st a gradual increase in pressure and a corresponding diminution of energy were observable.

3.—This depression advanced eastward over the Gulf of Saint Lawrence during the 6th and 7th, accompanied by fresh to strong gales to the thirty-fifth parallel; by the morning of the 8th the storm-centre had moved northeast over Newfoundland, and, after the 9th, disappeared in the direction of Greenland, its northerly course being apparently due to the presence over mid-ocean of an area of high barometric pressure.

4.—This depression was central on the 12th off the western extremity of Nova Scotia, where pressure ranging below 29.20 (741.7) was reported. From this position the storm advanced in a generally east-northeast course to the twenty-fifth meridian, and thence moved south of east over the British Isles by the 16th. While this storm was accompanied throughout by low barometric pressure and gales of marked strength, its northerly track prevented the disturbances by which it was attended from being severely felt over a considerable portion of the trans-Atlantic tracks.

5.—This depression was first located in about N. 53°, W. 20°, on the 21st, from whence it moved slowly eastward to the thirteenth meridian by the 22d, after which it passed northeastward over the British Isles, its course being attended by pressure falling to about 29.30 (744.2) and moderate to fresh gales.

6.—This depression passed eastward over Newfoundland during the 25th, and, pursuing a normal east-northeast course, reached the British Isles by the 30th. While this storm was unattended by unusually low barometric pressure or heavy gales, the following report from Mr. Jno. Higgins, observer at Saint John's, N. F., indicates the severe character of the electrical disturbances which accompanied its passage over Newfoundland: "A thunder-storm passed over Pools Island, Bonavista Bay, on the evening of the 25th which exceeded in severity any storm of this description heretofore reported from that locality. The lightning was vivid and did much damage. At Saint John's the lightning was blinding in its vividness and close to the earth, accompanied by heavy rain and thunder. It appeared to travel from west to east."

7.—This depression first appeared in N. 47°, W. 40°, on the 25th, with central pressure about 29.50 (749.3), whence it moved eastward to the twenty-fifth meridian by the 26th, and thence east-northeast to the southwestward of Ireland by the 27th; by the 28th the storm-centre had passed northeast over Ireland, after which it apparently recurved westward under the influence of depression number 6, which was central on the 29th to the westward of the British Isles.

8.—This depression is first located southeast of Nova Scotia under date of the 29th, when central pressure about 29.70 (754.4) and fresh to strong gales were reported west of the fiftieth meridian. By the 30th the storm-centre had moved northward to the south coast of Newfoundland, after which it apparently advanced north-northeast and disappeared north of the region of observation.

FOG.

The following are the limits of fog-areas on the north Atlantic Ocean during July, 1888, as reported by shipmasters:

Date.	Vessel.	Entered.			Cleared.		
		Lat. N.	Lon. W.	Time.	Lat. N.	Lon. W.	Time.
		° ′	° ′		° ′	° ′	
1	S. S. Elbe	40 20	67 45	.....	40 22	66 55	
1	Norseman	43 30	49 00	2 a. m	42 54	52 35	11.30 a. m.
2	Sarnia	52 45	51 49	6 p. m	52 56	51 11	9 p. m.
3	Italy	41 07	46 43	2.50 a. m.	41 14	45 11	9.30 a. m.
4	Aller	43 02	48 01	2.30 a. m.	42 29	52 01	1 p. m.
5	British Queen	42 55	58 36	4 a. m	42 53	59 20	7 a. m.
5	Main	44 53	43 26	2.54 p. m.	42 50	48 30	11.50 a. m.
6	Buffalo	43 51	42 55	6.30 a. m.	44 06	42 18	9 a. m.
6–7	Robina	36 15	75 05	8.10 p.m.	37 00	75 02	7.20 a. m.
6	Colina	52 13	53 50	11.30 a. m.	52 05	54 23	1 p. m.
6	La Normandie	42 40	47 49	2 a. m	42 22	48 55	6 a. m.
6–7	Lake Superior	53 26	47 38	.....	54 52	39 12	
7	Lann	42 14	50 50	8 a. m	42 25	48 45	2 p. m.
7	Colina	50 00	59 35	11 a. m	49 30	60 30	1.30 p. m.
8–9	Scythia	46 23	40 25	noon	43 23	47 38	3.56 p. m.
8–9	Circassian	Off	Belle	Isle.			
9	Baumwall	51 45	49 00	4 a. m	51 53	51 40	11 a. m
9–10	Ludgate Hill	40 39	58 30	6 p. m	40 40	53 30	11 a. m
10–11	Germanic	43 02	54 57	10.00 p. m.	42 38	56 42	4 a. m.
10–11	Austrian	42 25	69 02	9 p. m	42 30	65 46	1 p. m.
11	Republic	43 58	46 50	10.35 a. m.	42 52	52 17	4.29 a. m.
11–12	Ludgate Hill	40 47	50 30	1 p. m	42 26	46 00	10 a. m
11–12	Italia	42 54	48 24	.....	42 38	54 57	
11	Erin	41 10	54 00	2 p. m	41 10	55 00	6 p. m.
12	Siberian	54 00	45 00	3.55 a. m.	52 20	53 00	0.30 p. m.
12	Santiago	42 17	48 34	7 a. m	42 08	52 41	2 a. m.
12–13	Toronto	54 00	44 00	noon	52 20	52 40	4 p. m.
13	Wisconsin	45 08	44 22	noon	43 16	54 18	8 a. m.
13	Phœnician	45 01	43 51	3.50 a. m.	44 51	44 12	5.50 a. m.
13–14	Fulda	46 30	44 10	4.00 a. m.	44 50	52 25	11 a. m.
14	Belgenland	44 46	42 32	2.35 a. m.	43 50	44 42	11.35 a. m.
14–15	Phœnician	43 29	47 18	2.30 a. m.	42 16	51 01	3.24 p. m.
14	Fulda	44 46	52 55	1 p. m	43 46	56 24	12 p. m.
15	Durham City	49 30	42 36	0.30 a. m.	45 00	51 20	3 a. m.
15–16	Phœnician	42 19	51 55	8.30 p. m.	42 19	53 35	8.30 a. m.
16–17	Gothia	42 45	58 40	7 p. m	41 58	61 15	7 a. m.
16	Fulda	Nantucket Lt.		3.30 p. m.	Shinnecock.		11.30 p. m.
16	Adriatic	44 55	45 18	.....	44 49	45 45	
16–17	Sidonian	41 04	67 36	8.30 p. m.	40 32	70 40	0.45 p. m.
17	Tern. Gelert	40 01	70 17	1.30 a. m.	40 41	70 38	Noon.
17	Pavonia	42 12	65 43	1 p. m	42 08	62 50	7 p. m.
18	Phœnician	42 29	65 36	4.20 p. m.	42 25	69 42	4.52 p. m.
18	Hondo	40 00	70 00	7 p. m	40 40	69 50	11.30 p. m.
18–19	Adriatic	41 05	63 57	.....	40 58	64 57	
19	Saale	41 18	65 50	6.10 p. m.	41 07	66 25	8.20 p. m.
19	Pavonia	42 00	55 05	2.30 a. m.	42 00	53 40	8 a. m.
19–20	Hekla	41 30	64 20	4 a. m	40 36	71 30	9 a. m.
19	Durham City	42 45	63 00	8 a. m	42 30	69 40	12 a. m.
19	Adriatic	40 35	70 37	.....	40 30	71 15	
19–20	Nova Scotian	Off	Cape	Ballard.	46 29	53 20	
20	Aurania	43 33	48 00	9.12 p. m.	42 30	53 00	3.32 p. m.
20–21	Spain	41 35	49 00	5.30 p. m.	41 34	49 25	7 p. m.
21	Canada	40 53	68 02	7.28 a. m.	40 32	72 38	7.10 a. m.
21–22	Gellert	41 57	49 07	8 p. m	41 46	50 15	Midnight.
22	Nestorian	52 00	51 10	6 a. m	51 10	57 10	11 a. m.
22–23	Nevada	43 15	56 50	noon	42 49	59 00	8 p. m.
23–24	Istrian	44 23	47 26	10 a. m	42 35	53 39	2 p. m.
23–24	Gallia	44 15	46 35	9 a. m	42 47	57 50	5 a. m.
23–24	Gellert	41 04	64 01	midnight	41 02	64 41	2.30 a. m.
24	Nova Scotian	44 17	63 49	10 p. m	41 20	66 10	6 p. m.
24–25	Spain	40 50	68 20	1 a. m	40 44	68 45	2.45 a. m.
26	Brittanic	44 04	48 14	9.30 a. m.	42 40	55 37	9 a. m.
26–27	Cephalonia	42 00	48 50	.....	42 05	50 30	
26	Manitoban	46 58	46 43	10 a. m	45 33	49 44	2 a. m.
27	La Gascogne	46 57	50 27	5 a. m	45 44	53 18	1 p. m.
27–28	Circassian	Off	Belle	Isle.			
29	State of Penn	47 43	50 33	6.19 p. m.	47 10	51 47	2.27 a. m.
29	Michigan	43 15	44 25	5 a. m	42 36	45 45	4 p. m.
30	Galileo	42 51	50 55	.....	42 49	51 55	
31	City of Rome	45 27	45 37	.....	44 12	50 55	
31	Rugia	42 20	47 50	7.30 a. m.	42 20	48 05	8.30 a. m.
	Lann	45 38	44 30	1 a. m	45 26	45 15	3 a. m.

The limits of fog-belts to the westward of the fortieth meridian are shown on chart i by dotted shading. In the vicinity of Newfoundland fog was reported on twenty-eight days, as compared with twenty-three days for June, and the southern limit remained about the same. Over and south of Sable Island Bank fog was less frequently encountered than during the preceding month, while over and near Georges and Nantucket Shoals it was reported on thirteen days.

As compared with the corresponding month of 1887, an increase of five is shown in the number of days for which fog has been reported over or near the Newfoundland Banks during July, 1888, and the southern limits, about lat. N. 40° 30′, are the same in each year. An increase of five days of fog is also shown in the vicinity of Georges and Nantucket Shoals, where the fog-belt is extended somewhat to the east and west.

The almost daily occurrence of fog near Newfoundland during July, 1888, may be ascribed to the unusual prevalence of south to east winds in that locality, which directions were in turn occasioned by the presence or influence of cyclonic areas which so frequently appeared to the westward or northward. The differences in temperature between the warm, moisture-laden air from over the Gulf Stream and that which immediately overlies the surface of the cold Arctic current and ice-fields are more marked at this season, and fog is, therefore, more readily developed attending their contact. In the vicinity of Georges and Nantucket Shoals fog apparently originated principally from the air from over the warm waters of the Gulf stream being blown by south to east winds over the Shoals where the colder deep-flowing water of the Arctic current were forced to the surface, and in part by the intermingling of the warm ocean air with the colder northerly air currents from the land which followed the passage of cyclonic areas.

OCEAN ICE.

The following table shows the southern and eastern limits of the region within which icebergs or field ice were reported for July during the last six years:

Southern limit.			Eastern limit.		
Month.	Lat. N.	Long. W.	Month.	Lat. N.	Long. W.
	° ′	° ′		° ′	° ′
July, 1883	42 42	49 57	July, 1883	46 47	45 44
July, 1884	46 24	50 02	July, 1884	48 36	46 28
July, 1885	42 14	48 30	July, 1885	48 00	44 00
July, 1886	42 59	49 18	July, 1886	45 52	†34 30
July, 1887	43 30	50 05	July, 1887	52 04	41 16
July, 1888	*	*	July, 1888	47 40	50 10

*Off Cape Race. †An isolated iceberg and some field ice.

On chart i the following positions of icebergs and field ice are shown by ruled shading:

1st.—S. S. "Sarnia," from Greenly Island to Cape Norman, a great quantity of field ice and small bergs.

2d.—S. S. "Grecian," in Strait of Belle Isle, a large quantity of field ice and bergs; s. s. "Sarnia," from Cape Norman to Belle Isle, numerous large bergs.

3d.—S. S. "Felicia," 200 miles east of Belle Isle, an iceberg.

5th.—S. S. "Scandinavian," N. 47° 40′, W. 50° 10′, a large berg; s. s. "Lake Huron," 60 miles e. by n. from Belle Isle, a large berg, and in the Strait numerous bergs and field ice; s. s. "Lake Superior," many bergs in the Strait of Belle Isle, and a large one 70 miles to the eastward.

6th.—S. S. "Colina," from 20 miles east of Belle Isle through the Strait, numerous bergs; s. s. "Lake Superior," N. 52° 45′, W. 50° 57′, a large berg.

8th.—S. S. "Circassian," N. 50° 20°, W. 58° 40′, several large bergs.

10th.—S. S. "Baumwall," from 20 miles east of Belle Isle through the Strait, numerous bergs of various sizes.

12th.—S. S. "Sarmatian," N. 52° 28′, W. 53° 24′, 4.30 a. m., a large berg; N. 52° 23′, W. 53° 44′, 5.30 a. m., a large berg; 10 a. m., off Belle Isle, 40 large bergs; several small, flat bergs in the Strait extending from Belle Isle to Greenly Island; 60 miles west of Greenly Island, two large bergs.

13–14th.—S. S. "Siberian," small field ice along Labrador

and Newfoundland shores, and forty large and small bergs at entrance to Belle Isle Strait.

14th.—S. S. "Toronto," from Strait of Belle Isle to Point Amour, numerous icebergs; from Belle Isle Light to Greenly Island, many bergs close to the north shore.

15th.—S. S. "Concordia," from 60 miles east of Belle Isle, in Strait, and as far west as Greenly Island, a great number of bergs.

16th.—S. S. "Suez," off Cape Race, two bergs.

18th.—S. S. "Parisian," 60 miles east of Belle Isle, a great number of bergs; from Belle Isle to Point Amour, coast thickly studded with bergs, and from Point Amour to Mectina, a few bergs.

20th.—S. S. "Lake Winnipeg," in Strait of Belle Isle, a number of bergs; s. s. "Sarnia," from Belle Isle to Cape Norman, several bergs.

21st.—Several large and small bergs between Cape Norman and Belle Isle.

22d.—S. S. "Gothenburg," N. 46° 38′, W. 52° 45′, a small berg; s. s. "Nestorian," off Cape Norman, eight bergs.

23d.—S. S. "Hibernian," N. 52° 24′, W. 53° 32′, a large berg; s. s. "Cremon," N. 51° 30′, W. 55° 45′, a berg.

25th.—S. S. "Hibernian," from Belle Isle to Point Amour, a large number of bergs.

26th.—S. S. "Surrey," off Cape Race, two bergs; s. s. "Lake Superior," N. 52° 37′, W. 53° 18′, several large bergs; off Belle Isle, numerous large bergs; s. s. "Oregon," N. 52° 30′, W. 53° 06′, a few bergs; in Strait of Belle Isle, bergs.

27th.—S. S. "Circassian," off Belle Isle, a number of large bergs.

27–29th.—S. S. "Grecian," steaming along the east and south coasts of Newfoundland, saw two bergs, one off Cape Bonavista and the other off Cape Race.

28th.—S. S. "State of Pennsylvania," off Cape Race, four bergs close under the land.

In July, 1888, no ice was reported over the Banks of Newfoundland, and its presence along the south and east coasts of Newfoundland was not indicated during the first half of the month. Numerous icebergs and quantities of field ice were observed in the Strait of Belle Isle and off the coasts of Labrador and northern Newfoundland during the entire month. Subsequent to the 15th icebergs were encountered in the vicinity of Cape Race on six days.

As compared with June, 1888, the southern limit of ice has contracted about 3°, and the easternmost position in which ice has been reported for July is about 7° farther west than in the preceding month. The heavy flow of Arctic ice along the northern coasts of Newfoundland, noted during the latter half of June, has continued, while off the south and east coasts of Newfoundland there was a marked decrease in the quantity of ice observed. As compared with the corresponding month of previous years, the southernmost ice reported for July, 1888, was about 2°.5 north of the average southern limit, and the easternmost ice observed was about 6° west of the mean eastern limit. Off the east and south coasts of Newfoundland the aggregate quantity of ice reported was largely deficient when compared with the July average, while in the Strait of Belle Isle and along the Labrador and northern Newfoundland coasts the total amount observed coincided with the average for the month.

TEMPERATURE OF THE AIR (expressed in degrees, Fahrenheit).

The distribution of mean temperature over the United States and Canada for July, 1888, is exhibited on chart ii by dotted isothermal lines. In the table of miscellaneous data are given the monthly mean temperatures, with the departures from the normal, for the various stations of the Signal Service. The figures opposite the names of the geographical districts in the columns for mean temperature, precipitation, and departures from the normal show, respectively, the averages for the several districts. The normal for any district may be found by adding the departure to the current mean when the departure is below the normal and subtracting when above.

The temperature was below the normal in northern California, along the southwestern border from the lower Rio Grande valley to the Colorado River, in the Lake region, Ohio Valley, and in the states bordering on the Atlantic and Gulf. In all other districts it was normal or above. The greatest deficiency of temperature occurred in the upper Ohio valley, lower lake region, and in the states bordering on the Atlantic, the greatest excess occurring over the middle Rocky Mountain slope and Missouri Valley. Over the greater part of the country the monthly mean temperatures differed but slightly from the normal. The departures were nowhere more than 4° and at most stations were less than 3°.

The following are some of the most marked departures from normal temperatures at the older established Signal Service stations:

Above normal.	°	Below normal.	°
Huron, Dak	2.4	Norfolk, Va	4.7
Cheyenne, Wyo	2.2	Wilmington, N. C	4.1
Dodge City, Kans	2.0	Philadelphia, Pa	3.9
Fort Elliott, Tex	2.0	Charleston, S. C	3.5
Leavenworth, Kans	2.0	Savannah, Ga	3.5
Yankton, Dak	1.8	Hatteras, N. C	3.4

The maximum temperatures over the greater part of the country during the month were not unusual, but in a few districts, viz., the middle Pacific coast, Missouri and lower Mississippi valleys, they were exceptionally high, reaching, in numerous instances, within a fraction of a degree the highest recorded since the establishment of Signal Service stations, and at San Francisco, Cal., it exceeded the former July maximum by about 10°. At New Orleans the previous July maximum was also exceeded, that of July, 1888, being half a degree higher than the former maximum. The records at both New Orleans and San Francisco cover eighteen years. All of the unusually high temperatures occurred about the middle of the month, most stations reporting the maximum on the 15th.

The minimum temperatures closely approached, and in a few instances fell below, any previously recorded in the states bordering on the Atlantic and in the north Pacific coast region, those occurring about the 13th on the middle Atlantic coast being the most notable.

RANGES OF TEMPERATURE.

The monthly and the greatest and least daily ranges of temperature at Signal Service stations are given in the table of miscellaneous meteorological data. The greatest monthly ranges occurred over the plateau districts, eastern Rocky Mountain slope, and upper Missouri valley, where they generally exceeded 50°; they were, as usual, least along the Gulf and north Pacific coasts, where they fell to 25°, or below, at many stations.

The following are some of the extreme monthly ranges:

Greatest.	°	Least.	°
Boisé City, Idaho	59.0	Corpus Christi, Tex	17.0
Fort Klamath, Oreg	59.0	Galveston, Tex	17.8
Fort Verde, Ariz	58.7	Cedar Keys, Fla	19.4
Fort Assinaboine, Mont	58.0	Tatoosh Island, Wash	19.9
Fort Custer, Mont	57.9	Brownsville, Tex	21.8
Carson City, Nev	56.4	Key West, Fla	22.3

DEVIATIONS FROM NORMAL TEMPERATURES.

The following table shows for certain stations, as reported by voluntary observers, (1) the normal temperatures for a